TECHNICAL DEVELOPMENT REPORT NO. 103

COMBINED TONE AND PHASE COMPARISON LOCALIZER FACILITY

FOR LIMITED DISTRIBUTION

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Technical Development
February 1950

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TECHNICAL DEVELOPMENT
AND EVALUATION CENTER
INDIANAPOLIS, INDIANA

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Until such time as conversion from tone to phase comparison localizers is accomplished, certain airports will require both phase comparison and tone localizer installations on the same runway. This can be accomplished by installing two independent systems, one behind the other, and spaced several hundred feet apart. However, if both of these installations could be combined to use a single antenna array, many advantages would accrue, such as the economy incurred by using one antenna system, one transmitter building, and one localizer site. Furthermore, in some instances it would be physically impossible to obtain two sites to serve a single runway. This report describes a system tested at the Technical Development and Evaluation Center, Indianapolis, Ind., which provides simultaneous phase comparison localizer and tone localizer transmissions from a single antenna system.

An installation of this type requires a complete tone localizer transmitter including its modulating equipment as well as a complete phase comparison localizer transmitter with its associated modulating equipment. In an experimental installation these transmitters were operated simultaneously at carrier frequencies of 108.9 Mc and 108.3 Mc, respectively. The output of each of these units is fed to a pair of isolation bridges, as shown in Fig. 1, instead of being connected directly to carrier and sideband antennas. One of these bridges receives sideband energy from both transmitters and in turn feeds the sideband loops, while the other bridge receives carrier outputs of the two transmitters and in turn feeds the carrier loops. The complete antenna array is identical to that of a standard localizer installation.

The function of the radio frequency bridges is to feed the antenna array from two generators while maintaining isolation between the generators. If a source of energy is connected to junction D of the bridge, Fig. 2, energy will divide at this junction and travel to A and C. If an antenna is connected to junction A and a dummy load is connected to junction C, and if the impedances of both the antenna and the dummy are equal, the currents in these loads will be equal. Energy also will flow from A and C toward B. However, the additional one-half wavelength in bridge arm BC will result in zero voltage at B, regardless of the terminal impedance at B. Another source of energy can be connected to junction B, and by similar reasoning, will have no effect on any load connected to junction D. Thus the antenna at A receives energy simultaneously from both sources, yet the sources are isolated from each other. The antenna receives one-half of the power in the system while the dummy load dissipates the remaining power.

The arms of the bridge are constructed to be 0.15 wavelength long at a frequency midway between the two carriers. This selection of length makes the impedance looking into junctions B and D equal to the value of the loads at junctions A and C as explained herein. Looking into junction D, Fig. 2, it has been shown that there is no voltage at junction B due to energy supplied at D. Therefore, junction B is essentially a short circuit as viewed from D. The line AB, therefore, can be considered to be short-circuited stub 0.15 wavelength long connected at junction A, which is 0 15 wavelength from D. Similarly, CB is a short-circuited stub 0.65 wavelength long (which has an electrical impedance equal to a 0.15 wavelength stub) connected at C, which is also 0.15 wavelength from D From transmission line theory it is known that a short-circuited stub 0.15 wavelength long will reflect an impedance equal to twice the characteristic impedance of the line at a point 0.15 wavelengths from the point of the stub attachment. Therefore, the impedance at A is reflected at D, at twice its actual value. Similarly, the impedance at C is reflected at D at twice its actual value. When these two effective impedances at D are considered in parallel, the resultant impedance looking into D is equal to that of the line. The use of two bridges as illustrated in Fig. 1 permits the desired simultaneous operation of both tone and phase comparison localizer transmitters into a common antenna system.

To determine the characteristics of the course, course-width, and clearance, flight tests were made with recorders operating simultaneously on both tone and phase transmissions. Two Collins 51R-1 receivers were used. These recordings are reproduced in Fig. 3.

The course-width of each system was arbitrarily set at 3.5 degrees, this measurement being made at a point 15 nautical miles from the station. Approximately eight nautical miles of the course is displayed on these recordings, and it can be seen that the two courses are very nearly identical. It is believed that the slight irregularities in the courses were caused by reflections from a large system of experimental approach light structures which extended in both directions from the antenna array on a projection of the runway centerline. There is no evidence on these recordings of interaction between the signals. In these tests, both transmitters were simultaneously modulated with voice and localizer signals.

The two clearance recordings likewise are similar. The points of low clearance on these recordings are characteristic of the particular antenna array used.

The range of the combined tone and phase comparison localizers was 33 nautical miles at an altitude of 600 feet. Removing the bridges and connecting the antenna directly to one of the transmitters increased the service range of the facility to 38 miles at the same altitude. The loss of power in the dummy loads causes a reduction in service range of approximately 13 per cent.

It is believed that the selectivity characteristics of the receivers will determine the minimum possible separation between the two carrier frequencies, and it is apparent that large frequency differences would be unsatisfactory as they would unbalance the rf isolation bridges to an undesirable extent

In conclusion, it may be said that on the basis of the above tests, it is entirely feasible to operate both tone and phase comparison type localizers simultaneously into a common antenna system.

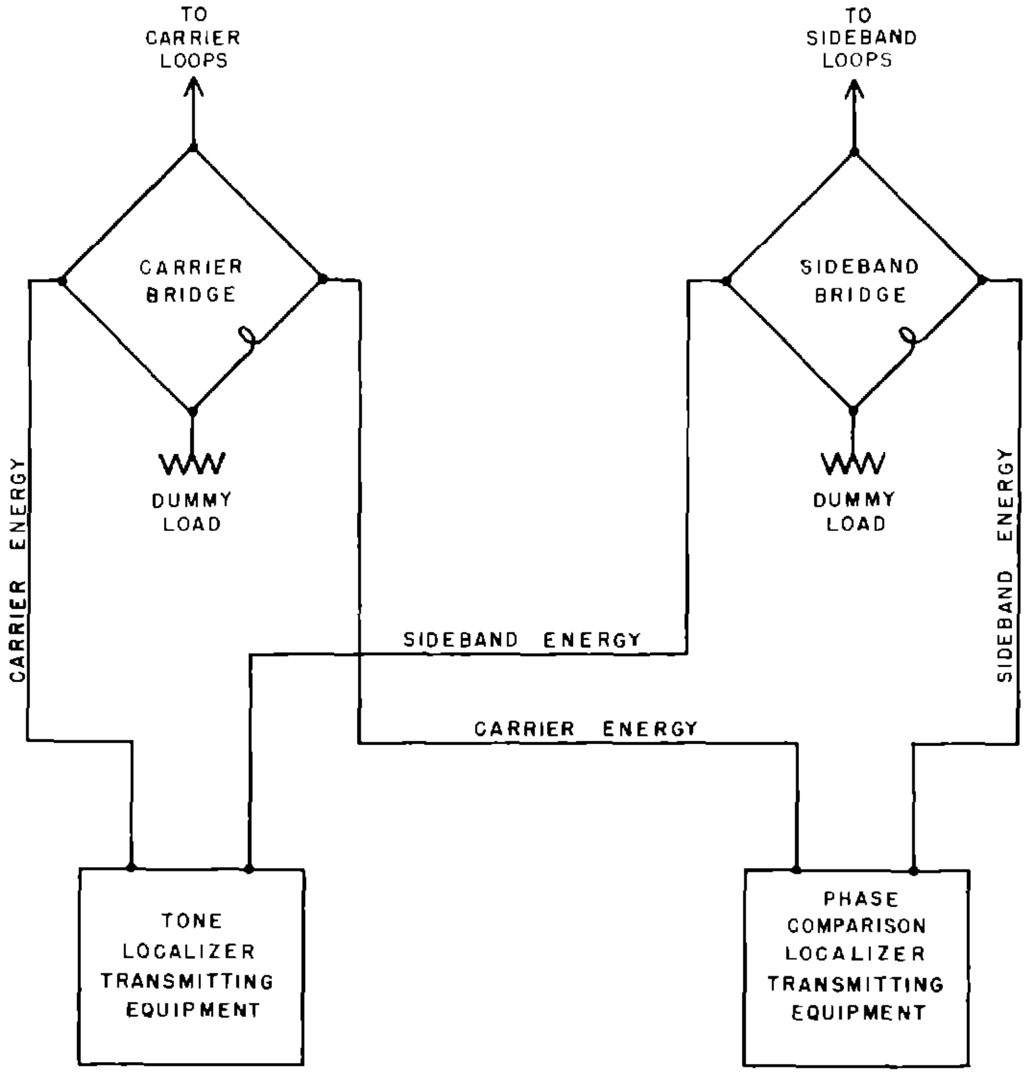

FIG 1 BLOCK DIAGRAM OF DUAL INSTALLATION

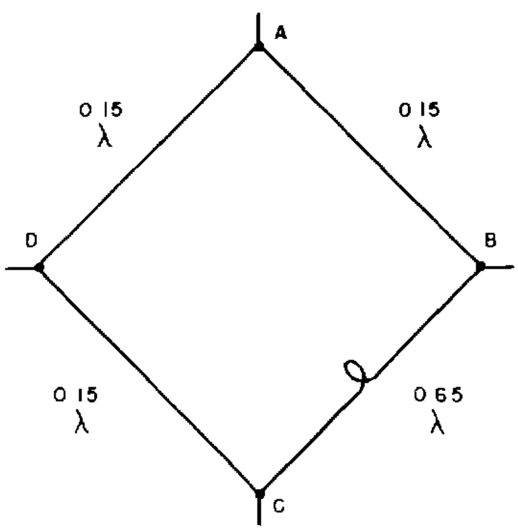

FIG 2 RF ISOLATION BRIDGE

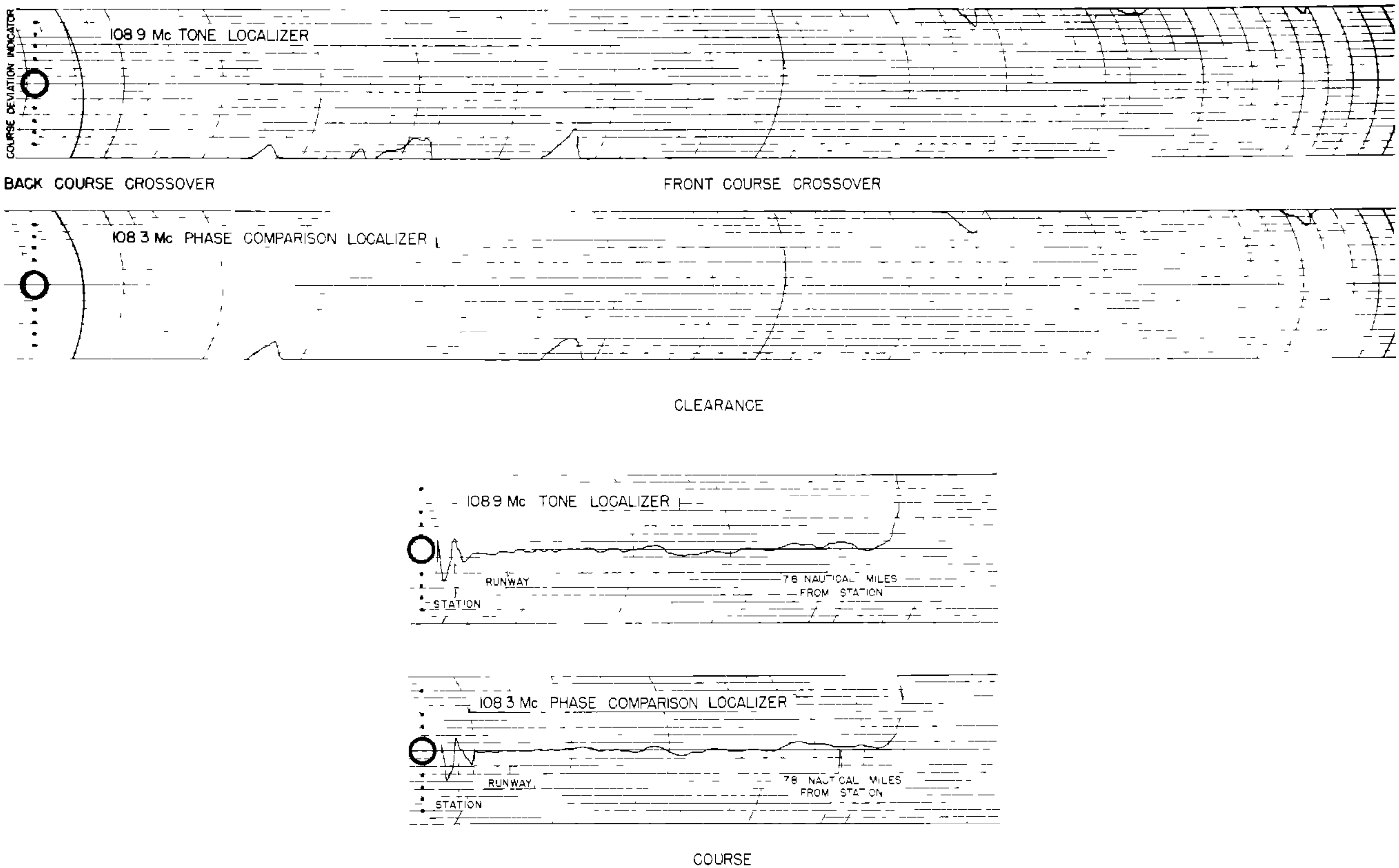

FIG 3 LOCALIZER FLIGHT TEST RECORDINGS